REPORT

OF THE

Committee of Twenty-Four of the River Improvement and Drainage Association of California.

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REPORT OF THE COMMITTEE OF TWENTY-FOUR OF THE RIVER IMPROVEMENT AND DRAINAGE ASSOCIATION OF CALIFORNIA.

GENTLEMEN: Your Executive Committee beg to submit the following report, indicating the methods used to examine into the conditions of navigability and drainage of channels of Sacramento River and tributaries; stating the conclusions reached, and embodying recommendations for the improvement thereof.

On the 28th of June, 1902, the entire Committee appointed at a mass meeting of people interested in swamp lands, held May 6, 1902, taking advantage of the courteous invitation extended to them by the Honorable, the Commissioner of Public Works, left Sacramento on the tug "State of California" to examine Sacramento River. They were accompanied by Col. W. H. Heuer of the United States Engineering Corps, and Messrs. M. A. Nurse and George N. Randle, Engineer and Assistant Engineer, respectively, of the Department of Public Works. Stops at Sherman Island and at other points of special interest were made, and the entire river to its mouth at Collinsville was examined.

Starting from Rio Vista next day, the Committee drove to Suisun, also over the ground where it has been urged to construct a so-called "cut through the Montezuma Hills" for the relief of the overflow of Yolo Basin and flood waters of Putah Creek, Cache Slough, and Steamboat Slough. Denverton and Maine Prairie were also visited, and much valuable data concerning flood marks, elevation, nature of the soil, etc., were gathered.

The following day the same tug enabled the Committee to visit Sacramento River above Sacramento City up to the Tisdale weir, the new cut-off below Knight's Landing, and also the Elkhorn weir.

The Committee take great pleasure in referring with grateful acknowledgment to the hearty and genial reception extended to them at the various localities visited; this is particularly true of their reception at Rio Vista and Suisun, where committees of citizens had gathered to receive and entertain them, and to take them for a drive in carriages to visit points in the neighborhood of special interest to the Committee and its work. At those points, as well as at all others along their line of examination, much enthusiasm in the work to be undertaken was shown; much faith in the new activity and purpose was evidenced. Your Committee received everywhere abundant proof that the time for

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action has come, and that the State and the people are ready to support those who will lead and push active measures for the obtainment of the end sought.

Sacramento Valley is traversed in its entire length of about 262 miles by a noble stream, destined to be a great boon and blessing to the State, not only affording a highway to deep-sea and inland commerce, but also, by the drainage and irrigation it can furnish, becoming the means of great wealth and prosperity to the adjacent lands.

Springing from the flanks of Mount Shasta, the little Sacramento is soon joined by Pitt and McCloud rivers, and after emerging from Iron Cañon at Red Bluff, reaches Jacinto, the point where the channel begins to claim our special attention, inasmuch as the banks below that point are low enough to make overflow possible. Fourteen miles below Knight's Landing, Sacramento River is joined by Feather River, a silt-bearing stream, and just above Sacramento City by American River; one and one half miles above Rio Vista the confluence of Sacramento River and Cache Slough and Putah Creek occurs, a circumstance fraught with serious results.

Unless discharged through breaks or escaping over the Elkhorn weir, all the water discharged by upper Sacramento, Feather, and American rivers must pass the channel from Sacramento to the head of Grand Island, two miles below Courtland.

Here Steamboat Slough delivers a portion of the water by a route eight miles shorter than Old River to the Rio Vista channel; at Walnut Grove, Georgiana Slough forms the first connection with the San Joaquin channel. It is twelve miles long, devious and too narrow to be of much service, however.

Private parties have further complicated the situation by damming off for private purposes Tyler and Jackson sloughs.

Previous to the advent of man, the waters of Sacramento River were pure and clear. In years of excessive rainfall, nature had provided by-passes and natural overflows, by means of which the water in the channel never acquired its present height, but was allowed to pass out quickly to tide water of San Joaquin and Rio Vista channels. On the reaches above Knight's Landing this is notably true of Sycamore, Wilkins, and Butte sloughs; while below Knight's Landing, the waters would escape in great quantity by "nature's weirs," the natural banks, unprotected by levees, partly through the Yolo Basin to Rio Vista channel, partly easterly of Sacramento City to San Joaquin River.

It has been the misfortune of the State that all attempts to control the flood waters of Sacramento River have been undertaken piecemeal by private interests, each man spending his own funds for the protection of his own selfish ends, regardless of the effect that improvement or

change in local conditions might or must necessarily have on other sections above or below him. And worse than that, the system has for many years prevailed in the councils of many reclamation districts, organized under the general laws of this State and for public purposes, that the only way to keep their heads above water is so to protect their own land as to drown out their neighbors, opposite, above or below.

One broad, comprehensive scheme, attempting the improvement of the channel, for navigation and drainage, as a whole on scientific lines of modern hydraulic engineering, was never undertaken or even seriously considered.

Thus the construction of a very solid dike on the left bank of American River, connecting the highlands to the east with the left bank of Sacramento River, reclaimed the capital of the State, which formerly, notably in 1862, had been subject to frequent inundations; but it also succeeded in playing sad havoc with an important natural outlet of the flood waters of the State, causing changed conditions, higher flood marks, breaks and devastation in places formerly supposed to be perfectly safe, and disturbing the provisions of nature for the drainage of Sacramento Valley.

Thus the construction of the line of levees fifty miles long on the left bank of Sacramento River, from Sacramento City to the foot of Brannan Island, by the adjacent land-owners, had the locally beneficial effect of reclaiming the lands protected by the said levees, of creating conditions of great prosperity and wealth; but from a hydraulic standpoint, it had the disastrous effect of preventing the working of the natural outlet over that bank, which formerly acted as one immense "natural weir" over its entire length; it also raised the river floods to heights formerly unknown, causing breaks on the opposite or Yolo side, first at Washington, then at Payne Break; and when those were stopped, lower down at Clarksburg; which all, not only yearly devastate what undoubtedly is destined to become one of the most prosperous sections of the State, but seriously disturb the proper discharge of the waters through Sacramento River channel.

Thus the partially successful operations of owners of lands adjacent to Sacramento River, between Colusa and Knight's Landing, aimed at reclaiming their lands without giving much thought to the manner and extent to which their work might affect the channel above and below them,—they justly concluded that the damming-off of Sycamore, Butte, Wilkins, and several other sloughs and outlets would materially reduce the mileage of levees required for the reclamation of their lands; but they did not consider that thus closing up several of the most important outlets of river water left the only available channel at flood times to discharge at least thirty-three per cent more water than it was able to convey, and the result was a rise in the flood plane to elevations

never before dreamed of; hundreds of thousands of dollars were in years gone by spent by various reclamation districts in the vain and foolish attempt to have the size and height of their levees keep pace with the constantly rising flood marks. At Grimes's Landing, for instance, a general rainfall of ten inches usually caused the river to rise over twenty feet in twenty-four hours.

Of late, relief has been sought in the construction of weirs, which were intended to prevent lateral discharge until the river rose to a certain height. The weirs have undoubtedly granted local relief, but the result on the problem of water distribution and discharge has been to add greatly to the complications of difficulties to be solved.

Cuts or crevasses near the Tisdale and Elkhorn weirs have, during recent floods, discharged too much water. This, in the case of the break adjacent to Tisdale weir, had the fatal effect that in a short space of time so much water rushed by the short cut through the Sutter Basin that it caused Feather River flood plane to raise Sacramento River to such an extent that it was actually higher at its confluence with Feather River than at Knight's Landing, situated fourteen miles up Sacramento River, as was evidenced by the fact that logs actually floated up the Sacramento (though down current) from mouth of Feather River to the breaks at Knight's Landing.

The breaks adjacent to the weir at Elkhorn and adjoining breaks worked in much the same way. They should be permanently closed and flood relief confined to the weirs. These breaks let a great deal too much water into Yolo Basin, with the result that although in February, 1902, we had at Sacramento City only 6.52 inches of rain, the water seemed to accumulate at the foot of Grand Island all at once in enormous volume; Rio Vista is situate only fourteen and a half miles from tide water at Collinsville; still the gauge at Rio Vista registered on March 2, 1902, fourteen feet above low tide, showing a gradient of almost one foot per mile for Rio Vista channel; the entire basin seemed one roaring sea, spreading waste and devastation, threatening dikes which had been supposed to be safe beyond peradventure, and overtopping others. Sacramento River channel from Walnut Grove to foot of Grand Island, Sacramento County, was a sluggish stream almost standing still, as the water at Rio Vista was so high as to allow of no outfall.

Thus in almost all of its sections the economics of water distribution were upset and disturbed, and in many instances entirely destroyed; some sections, running up-stream; others, which ought to be traversed by swiftly-running currents with velocity of from five to six miles per hour, almost standing still.

No wonder that many interested in the welfare of the valley inquired, if such conditions were created by a seasonal rainfall at Sacramento City of only 15.16 inches in 1901–02, what might be expected if we

should be visited by a seasonal rainfall of 35.6 inches, as we had in 1862; and pronounced the task of grappling with the problem before us a hopeless one.

Your Committee, while fully realizing the seriousness and gravity of the problem before them in all its phases, are, however, glad to be able to announce their conclusion that whatever has been spoiled and disturbed by the folly and thoughtlessness of man, can also by man be rectified. What is needed in the first place is a hopeful spirit, a firm conviction of ultimate success, a ready will to join hands and set to work.

Having thus briefly stated the almost hopelessly bad and neglected present condition of Sacramento River channel as a waterway, for navigation and discharge of flood waters, your Committee will now proceed to state their conclusions and recommendations for the improvement thereof.

As a result of examinations and careful study, we are enabled to report as our unanimous opinion that it is possible and feasible, at a comparatively moderate cost, so to improve and widen the channel of Sacramento River that, with a possible exception of extraordinary floods (when weirs will have to furnish the needed relief), the entire flood waters of the combined upper Sacramento, Feather, and American rivers and of Cache Slough can be confined in one channel.

This result can not be reached in a year, but should be the one goal toward which tend all measures proposed for improvement. It is believed that when the river shall have scoured down its own improved channel, and levees on both sides have been gradually strengthened and raised, it will be found both possible and expedient, tentatively to raise the crests of the weirs now constructed. When once this is accomplished this would cause a complete metamorphosis of conditions in Sacramento Valley, to wit:

First—Strong tidal action up to and beyond Sacramento City.

Second—A water channel making possible deep-water navigation to Sacramento City, and bringing Colusa, Marysville, and points beyond, within reach of ships drawing ten or fifteen feet.

Third—A thorough reclamation of the five basins (so called), creating conditions of wealth and prosperity for the waste lands situated westerly and northerly of Sacramento City as far as Jacinto and Chico, similar to those now existing on the fertile bottom lands on the lower reaches of the river.

Having reached this conclusion, your Committee have earnestly sought a remedy for the deplorable conditions existing, and there is no doubt in their minds that the first and main cause of the present trouble is the fact that the channel below Rio Vista is too narrow and tortuous

to admit a free passage to tide water of the constantly increasing masses of water which accumulate at that point at flood stages.

As we deem it wise to limit our efforts at present to the correction of the Rio Vista channel, we wish to call special attention to the conditions now existing there.

On the right bank of Sacramento River, between Rio Vista and Collinsville, the Montezuma Hills prevent a lateral discharge of flood waters to the west. In former years they overtopped the left banks and found an easy escape easterly to San Joaquin tide water. The building of levees on Brannan and Sherman islands opposite and above the Montezuma Hills in late years, has prevented such lateral discharge and has forced the enormous mass of waters accumulating at Rio Vista to find its way to tide water through a channel which is fourteen and a half miles long, in one place but seven hundred feet wide, and which by alignment and cross-sectional area is entirely insufficient and unadapted to do the work it is called upon to perform. The breaks in the Sherman Island levee have by diminution of flow caused the formation of bars, and have further lessened its usefulness by decreasing the cross-section area of the channel.

On March 2, 1902, the river at low tide at Antioch and Collinsville marked two tenths of a foot above zero, or mean low tide at Antioch, which is the datum referred to in all surveys in this report. At the same time at Rio Vista, fourteen and a half miles distant by river channel, the river marked fourteen feet above zero; showing a fall of almost a foot per mile, which in a tidal stream is absurd.

This condition of affairs demonstrates conclusively the existence of a gorge below Rio Vista; it is caused by a channel too narrow and of bad alignment and by the existence of bars at the mouth of the river below Collinsville.

At Toland's Landing the river butts in a direct line against the Montezuma Hills, while a sand-rock formation of the banks at that point has prevented the river from widening the channel. The fact that a very large amount of water escapes through Three-miles and Seven-miles sloughs, explains the fact that the channel immediately below the confluence (at Horseshoe Bend) is shoaling somewhat.

We are positive that the fact of the tidal channel below Rio Vista being choked is at the root of all of our difficulties.

It prevents quick "inhaling," by Suisun Bay, at each low tide, of the waters accumulating above Rio Vista; it is the cause of the unheard-of high-water marks, causing destruction to levees of Sherman, Brannan, Egbert, Ryer, and Andrus districts, and seriously threatening others; it explains the excessive flood heights of Cache Slough, preventing it from draining Yolo Basin; and it also explains the "waterdam" (so called) at the confluence of Old River and Steamboat Slough, and which

in its turn causes those waterways to stand still and even run up stream at flood times.

By thus diminishing the current velocity in those streams, it is also the cause of the formation of sand bars therein.

If, now, we assume for a moment that the channel below Rio Vista were so corrected and improved that the gauge at Rio Vista, even in an 1862 flood, should mark, at low tide, say five feet above zero, and at high tide say nine feet above zero, the waters would be prevented, even in the highest floods, from ever reaching at Rio Vista a height above nine feet, or five feet below high-water mark of March 2, 1902.

At each low tide it would drop, say four feet, causing such a current velocity in Steamboat Slough and Old River as to aid immensely in scouring out of those channels the sediment and "slickens" deposited there by the operation of hydraulic mining; it alone would have a great influence on high-water marks at points above, even at Sacramento City wharf probably as much as two feet; it would solve the Cache Slough problem, as that stream and adjacent territory would be easily drained; it would increase tidal action to such an extent in the summer months that a strong tidal oscillation would be felt at Sacramento City. This increase of tidal in- and out-flow would further materially assist in creating and maintaining a deep-water channel. Incidentally, it would make possible the reclamation of valuable tracts of land now despaired of and practically abandoned.

Your Committee believe thus to have demonstrated that the step to which our first and exclusive attention should be directed at the present time, the one measure that should receive precedence over all others for relief, is the finding of means, efficient and practicable, for affording to the enormous volume of water now presenting itself at Rio Vista for passage, an easy, short, and effective way of escape to tide water.

MONTEZUMA CANAL.

Among residents on the banks of Sacramento River, a popular belief exists that the cheapest and most practicable solution of the problem would be the construction of a canal called "The Montezuma Canal," an excavation through a depression in the hilly region between Rio Vista and Suisun, which, connecting Maine Prairie and Denverton, would give an easy drainage to Cache Slough and Yolo Basin and thus relieve Rio Vista channel.

Your Committee visited the locality, examined the conditions, and found the swale reached by excessive waters of Cache Slough. The reason for the popular belief is quite apparent. At such excessive stages, the waters of Cache Slough reach far inland, and the distance between such overflow and the water at Denverton is not excessive, so that it would seem easy to connect the two sheets by a ditch.

It is forgotten that to be effective, the bottom of the ditch would have to be at least ten feet below low tide, and twelve hundred feet wide. The greater portion of the canal would run over lands at an elevation of from twenty to forty feet above low tide where the soil is hard and partly rocky. A rough estimate of the cost of a similar canal would bring the expense in the neighborhood of $10,000,000. Assuming even that it were possible to procure such a sum for such a purpose, the result would be a division of the flood waters into two deep tide channels, which is not desirable.

CUT THROUGH SHERMAN ISLAND.

Your Committee have carefully examined into the next proposition, the straightening out and widening of Rio Vista channel by cutting off Horseshoe Bend, and were at first much impressed by it. We consider ourselves, however, fortunate to be able to state that a better, shorter, easier, and absolutely efficient way to procure an outlet to tide water has been found.

The channel from Rio Vista to Collinsville is fourteen miles in length. To widen and improve the same, and to correct its mouth, would cost at least $500,000.

The lower reaches of San Joaquin River are one mile wide, and for all practical purposes can be considered as tide water.

In making a cut through Sherman Island 15,000 feet long, and say 1,300 feet in width, gradually widening to 1,400 feet, the distance from Rio Vista to tide water would be reduced by eight miles, and would by actual measurement be six and a half miles.

As will be seen by the accompanying map of lower Sacramento and San Joaquin rivers, the relief afforded would be by a direct line. San Joaquin River is so wide at the point of proposed junction that it is believed the confluence would not affect its plane to the extent of one tenth of a foot.

Your Committee feel assured that by the construction of this new mouth of Sacramento River, high-water mark at Rio Vista, even in an 1862 flood, would never rise to within five feet of that reached on March 2, 1902. This would allow a fall of six inches to the mile, which is ample, and will probably be found to be well in excess of actual conditions, when once the new channel will be in proper working order.

While, moreover, at present, the amount of water daily supplied and accumulating at that point far exceeds the volume which the channel below Rio Vista can deliver, the cut proposed would prevent such gorging, as at each low tide the enormous area of Suisun Bay would be able to receive such amounts as had collected during the previous high tide. The beneficent results of thus promptly carrying off the flood

MAP OF THE
LOWER SACRAMENTO
&
SAN JOAQUIN RIVER

SHOWING PLANS
FOR PROPOSED IMPROVEMENT

T. 4N. R. 1 E.

T. 4N. R. 2 E.

T. 3N. R. 1 E.

T. 3N. R. 2 E.

T. 2N. R. 2 E.

Vurso
Montezuma
Mtns Ldg
Birds Ldg
Montezuma Slough
Grizzly Slough
Roberts Island
Roberts Creek
Roberts Cr.
Collinsville
HW 8 Z 1902
CHAIN ISLAND
VAN SICKLE ISLAND
Spoonbill Creek
CHIPP'S ISLAND
Middle Slough
BROWN'S ISLAND
New York Ldg
New York Slough
Pittsburg Ldg
Cornwall
Antioch
HIGBEE I.
WEST ISLAND
Marsh Ldg
SACRAMENTO RIVER
Mayberry Slough
SHERMAN ISLAND
PROPOSED CUT OFF
SAN JOAQUIN RIVER
Dutch Slough
Toland Ldg
HORSESHOE BEND
Emmaton
CARROLL WHARF
Jersey Ldg
Bradford Ldg
Taylor Slough
False
Serpent Slough
River
MONTEZUMA HILLS
RANCHO DE LOS ULPTNOS
Rio Vista
Newtown
HW 4 O'NK
WOOD ISLAND
BRANNAN ISLAND
ZEILES WHARF
3 Mile Slough
7 Mile Slough
TWITCHELL ISLAND
Cache Slough
RIVER
CONTOUR 10
CONTOUR 30
20
30
40

waters to tide water at each succeeding low tide can hardly be over-estimated.

It would of itself increase tidal action to an enormous extent, thus insuring greater scouring action by greater daily discharge of volume; it would also greatly increase the velocity; and these combined agencies must necessarily result in materially deepening the channel.

The cut proposed would be made in soft peaty land situate at an average elevation of three feet below low tide. In order to obtain the best possible results, the entire channel below Grand Island ought to be made of a uniform cross area; funnel shaped; and we recommend the construction of a channel 1,200 feet wide at the confluence of Old River and Steamboat Slough, gradually widening out to 1,300 feet at the beginning of the cut proposed and 1,400 feet at the end thereof.

This work will entail the construction of small jetties at the foot of Brannan Island and a widening of the channel on the right bank. According to the estimate made at our request by the Department of Public Works, this entire channel correction could be made for about $400,000. In view of the fact that the proposed Montezuma canal, which would have to be excavated to an average depth of thirty feet with a length of eight and a half miles, and at a cost estimated at $10,000,000, would but partially accomplish what has been shown can better be done for $400,000 by making a cut two and a half miles long to a depth of, say ten feet, your Committee is fain to express the hope that the "Montezuma canal" proposition, that fruitful discussion among sapient river residents, will no longer be considered in a serious discussion for devising plans to relieve Sacramento Valley from river floods. It has been unfavorably reported upon by every engineer who has ever estimated its cost, during the last twenty-five years, and it ought long ago to have been dead and buried, and should hereafter remain so.

As a corollary to the proposed cut through Sherman Island, the improvement of the mouth of San Joaquin River below Antioch would have to be undertaken. It is a matter of sincere congratulation that the U. S. Engineering Corps is not only in full accord with the views of your Committee, as herein expressed, in reference to the cut through Sherman Island, but, if Congress authorizes, is willing to undertake the improvement at the mouth of San Joaquin River at National expense.

Your Committee are of the opinion that the cut proposed will be the first important step toward the solution of the great problem before us. The problem at the present time confronting us is the construction of a channel below foot of Grand Island to tide water, of proper alignment, width, and depth to accommodate the combined waters of Cache Slough, Steamboat Slough, American, Feather, and Sacramento rivers. This

we are convinced the proposed cut through Sherman Island and proposed channel correction will furnish.

That work accomplished, the next step will be to procure a channel from foot of Grand Island northward to mouth of American River, for the combined floods of the three rivers last named.

Finally, a new channel for Sacramento River proper above mouth of Feather River will have to be made, of such character as will prevent excessive flood heights at Colusa and points below, and as will enable adjacent land-owners to build levees which can cope with the situation, even in an 1862 flood.

With this cut through Sherman Island finished and permanent water gauges established along the river at not too large intervals, the problem of taking care of the flood waters of Sacramento Valley can gradually and surely be accomplished. The gauge readings at flood periods would give us invaluable information of the existence of insufficient channel areas, and in case the fall in the flood plane between any two gauges should, for a given distance, greatly exceed the average, it would indicate the fact that the river was choked at that point and a remedy could be found. This could be afforded either by cutting off a point by a dredger, by scouring out the channel bottom by properly directing the current by jetties, or by widening the channel in a certain section.

By working up stream in this way, we will gradually reach the upper Sacramento, and a happy and perfect solution will have been found for the reclamation of the lands bordering upon that stream.

Neither will this work require a very long space of time. Assuming the necessary appropriations were promptly forthcoming, two years ought to finish the cut through Sherman Island; two years more ought to bring us to mouth of American River, and two years after that at Colusa and points above.

But at present all the energies of every man having at heart the welfare of the two valleys should be centered on that one initial step. Means to obtain the necessary funds will be discussed later.

WEIRS.

Two concrete weirs have been constructed by the Department of Public Works—at Elkhorn and near the former Tisdale break. They are both permanent structures, and have been made with a view to control flood heights at points below.

The Elkhorn weir begins to work when the river at Sacramento City marks 22.5 feet at the gauge at the foot of K Street. It was constructed with a view to prevent that gauge from registering above 27.5 feet. The overflow runs through the Yolo Basin and empties into the channel above Rio Vista.

The Tisdale weir has a crest 3¼ feet below flood height, and is constructed to relieve the levees of Sacramento River on the east and west below that point, and it has been successful in bringing about that result. The overflow runs through Sutter Basin and reaches the channel of Feather River near its confluence with Sacramento River. In order to perform the work for which the weirs are intended, the levees above and below should be kept up. At present this is not the case, as breaks in the levees reduce their efficiency, if they do not entirely destroy it. Your Committee are of the opinion that the weirs at present constructed should be maintained, but that their number should not be increased. The ultimate aim in river improvement should be so to improve, widen, and deepen the channel that weirs are no longer necessary.

Modern hydraulic engineering looks upon water not as the enemy, but as the best friend of the hydraulic engineer. In a sense it may be said that there can not be too much of it, provided of course a channel exists or has been constructed of sufficient area and proper alignment to enable it to take care of the flow. The more water we can crowd in that channel, the more tide water we can induce to enter it at every high tide, the better; for it should be our aim to create strong tidal action at least up to the mouth of Feather River; when that has been accomplished all the other improvements will be found to be of easy solution. We should be grateful that upper Sacramento River furnishes throughout the entire year a flow sufficient to create and maintain a perfect channel in places twenty-five feet deep. If that were to fail us our difficulties would be greatly increased.

In regard to the work on upper Sacramento and Feather rivers we recommend that all lateral escapes of floodwater (except over the weirs now constructed) be prevented at once, in order to keep as much water in the channel as possible. The estimated cost of this work is $40,000.

We further believe that the opening up of channels below Sacramento City should precede the undertaking of works entailing a comprehensive plan for the solution of the complicated problems of drainage and protection of lands above Sacramento.

This River Improvement and Drainage Association of California should pledge itself to advocate the undertaking of that work just as fast as the river below has been improved sufficiently to make the execution of such a plan feasible.

Any money spent in that direction now, except as indicated above, would be worse than wasted, as it would not give permanent relief and only further complicate the situation.

CUT-OFFS.

One cut-off was constructed in Sacramento River above the mouth of Feather River, and is undoubtedly an improvement. Navigation and

drainage were much improved thereby. We understand that the current has scoured it down to a depth corresponding with adjacent sections.

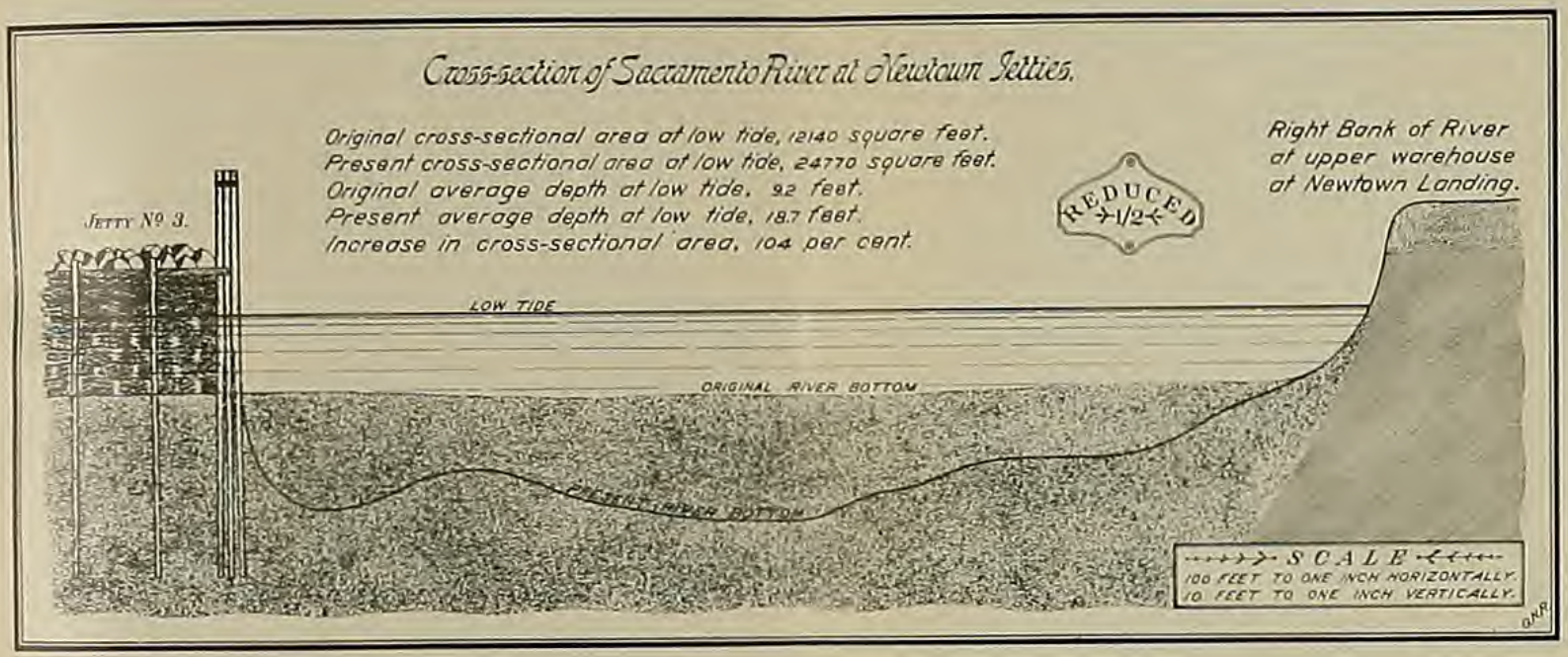
JETTIES.

The U. S. Engineering Corps has, in a number of places, especially in the shallow reaches below Sacramento City and immediately above and below Isleton, constructed jetties in a position perpendicular to the current line, having the purpose and effect of narrowing the channel at those points, where, by reason of a too wide channel, the current velocity has been reduced to such an extent as to cause the deposit of sand and sediment, resulting in bars, contracted channel area, and serious impediment to river navigation. The State Department of Public Works constructed in 1898 five jetties at a point known as the Newtown Shoals, one half mile above Rio Vista, in order to remove such shoals, at an expense of about $36,000. The result of the construction of those jetties has been uniformly beneficial and resultant in increased channel area and channel depth. The best proof of this assertion is the result of the work achieved at the Newtown Shoals.

The accompanying sketch showing cross-section of Sacramento River at Newtown jetties, furnished us by the courtesy of the Department of Public Works, shows that whereas in 1898 we had a channel 2,800 feet wide, with a depth varying from 7 feet to 0, causing serious impediments to navigation and drainage, we have now a channel with a width reduced to 1,300 feet, but with an average depth of 18.7 feet, and with a present cross-sectional area of 24,770 square feet, against an area of 12,140 square feet in 1898; a gain of 104 per cent in cross-sectional area.

As a further proof that the jetties constructed by the U. S. Engineering Corps and by the State Department of Public Works have not failed to perform the work for which they were constructed, we point with pride to the fact that whereas formerly, previous to 1898, tidal action ceased at Walnut Grove, we now find a strong current running up stream past Vorden, Courtland, and Richland—a gain of twelve miles.

At the time of the writing of this report the beneficial effect of the jetties by increased scouring action of the river is shown by the gauge reading at foot of K Street, Sacramento. It shows the river to be at 6.9 feet, or lower than at any time for the last fifteen years, and we note that, notwithstanding this lower elevation, channel-area has increased and the bed of the river has been lowered very materially. While the mail-boats in former years could not reach Sacramento City wharf during two months of the year, unless they had been lightened by partly discharging their cargo on barges, the captains now report an excellent channel; and this notwithstanding the fact that after the steamboat


Cross-section of Sacramento River at Newtown Jetties.
Original cross-sectional area at low tide, 12140 square feet.
Present cross-sectional area at low tide, 24770 square feet.
Original average depth at low tide, 9.2 feet.
Present average depth at low tide, 18.7 feet.
Increase in cross-sectional area, 104 per cent.
REDUCED 1/2
Right Bank of River at upper warehouse at Newtown Landing.
Jetty No 3.
LOW TIDE
ORIGINAL RIVER BOTTOM
PRESENT RIVER BOTTOM
SCALE
100 FEET TO ONE INCH HORIZONTALLY.
10 FEET TO ONE INCH VERTICALLY.
G.N.R.

"Modoc" burned down, the "Onward," which draws one foot more water, was put in her place.

All this should be an encouragement for us to continue on the lines laid down, and it is believed that the cut proposed through Sherman Island alone, would cause tidal action to be strongly felt in Sacramento City. It need not be pointed out that such increased tidal action means increased volumes of water daily traversing the channel, a circumstance which can only be most beneficial to the scouring action of the river.

To the uninitiated, only looking at the surface of things, these jetties may seem to obstruct the free flow of flood waters; but this is not the case. They are in accordance with good hydraulic practice, and should not be disturbed. As this Committee has been asked to examine into and report upon those jetties, we have thought it proper to express our opinion on that point. If we have a criticism to make in that regard, it would be that they are not constructed in a manner sufficiently permanent and substantial. The heads have frequently been allowed to be washed away by the increased current; they should be protected by stone and rock in every instance.

We further recommend that the crests of the jetties be not raised higher than one or two tenths of a foot below low water (low tide), in order not to interfere unnecessarily with high water and flood flow; the scouring action of the stream will remain just as effective.

It is a great pleasure to us to refer in this connection and at this place to the conscientious, efficient, and honest work which has been done by the staff of the Department of Public Works. Not only has it kept away from politics and its baneful influences, but it has earnestly and honestly endeavored and succeeded in doing the utmost with but scanty means.

While a goodly number of previous Commissions, Departments, and Engineers have contented themselves with drawing salaries for themselves and deputies, and writing up big reports at each session of the successive legislatures, containing a mass of partly undigested data, and for a good deal consisting of reprinted matter contained in previous reports, all of which cost a good deal for printing alone, Messrs. Nurse and Randle have been the first actually to go in the field and accomplish results.

In comparison with the manner in which the State money has been spent in previous years, this is refreshing and gratifying, and should receive proper acknowledgment by all parties interested.

WATER GAUGES.

Your Committee have been hampered considerably by a lack of properly compiled records of high- and low-water marks along Sacramento River. Gauges have indeed been placed here and there by

different engineers at different times against a pile or on a mud flat, but they have all been carried away by floods, mischievous boys, or destroyed by steamboats knocking the piles down. No systematic system of taking daily readings and reporting them to one central authority has been inaugurated.

It is recommended that an effort be made at once for organizing a system for obtaining daily readings at all mail landings and other important points. That for that purpose, substantial concrete piers be constructed, with floats designating the height of the water at that point. The captains of the mail boats or the wharfingers should be requested to make daily readings and report same monthly to the Department of Public Works at Sacramento, where a clerk should be employed properly to compile, record, and publish the same. No comprehensive plan of river improvement is possible without accurate data of river conditions. No data can give more intelligent information regarding river conditions, obstructions, gorges, reduction in current velocity, tidal action, etc., than properly compiled readings of river heights. A sum of $5,000 should be set apart at once for the construction of such concrete water gauges.

SAN JOAQUIN RIVER.

We recommend that the river improvement work already begun on the lower San Joaquin River be continued along the lines heretofore designed, to the end that the river bends be eliminated and the water channel be deepened and rectified; and such work be undertaken and commenced on the upper San Joaquin as will lead to a longer and more certain season for boats engaged in carrying the products from the valley counties to the seaboard, and that a sum of money adequate to the carrying out of such improvements be set aside by the Board of Public Works for such purposes.

Also that a sum of $60,000 be set aside for the purpose of acquiring the needed right of way for the canal to be constructed by the Federal government, intended to divert Calaveras River into San Joaquin River at a point below Stockton.

MOKELUMNE RIVER.

Your Committee, accompanied by the Department of Public Works, visited also the Mokelumne River above New Hope Landing. Its free flow was found to be seriously obstructed by numerous snags, causing obstacles to navigation and drainage.

The land-owners interested have gone to considerable expense in attempting to enlarge the area by making cut-offs and clearing the channel. Your Committee recommend that, in case the land-owners of

adjacent lands are willing to cut down the trees now growing on the banks of said stream, between the levees and the river, a sum of $40,000 be appropriated and set apart, to be spent by the State Department of Public Works, for removing snags and improving the river channel in Mokelumne River between New Hope Landing and Woodbridge.

FINANCES.

In discussing the proper methods to raise the funds required for the carrying out of the work herein recommended, your Committee have reached the conclusion that it would be desirable that a united effort be made, by all parties interested, at the next session of the Legislature of this State, to obtain from it a grant of $750,000 to the State Department of Public Works. Serious doubts exist whether any attempt to raise the amount by special taxation, or by any other means whereby the funds are to be contributed by adjacent land-owners or cities or counties interested, will be successful, by reason of the difficulty, if not the impossibility, of properly and fairly apportioning them, and by the endless litigation it would be sure to entail. Moreover, the opening up of the great highways of commerce, and the draining of the two great valleys of the State, insuring their prosperity and largely increasing their ability to share in the just burdens of taxation, are essentially State interests.

While it may seem that the funds to carry out the proposed work should largely, if not entirely, be borne by the National Government, to whose exclusive care all navigable rivers are intrusted, your Committee hesitate to advise waiting until funds from that source are available.

It is believed that if the two great valleys and all lands interested will join hands in one great effort, such representations can be made to our State Legislature that no serious difficulties will be experienced in inducing the proper grant to be made.

What is needed is an united effort—a long pull, a strong pull, and a pull all together—and we will succeed.

All of which is respectfully submitted.

FRANK MILLER, President,
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B. G. PEART,
L. TARKE,
J. H. GLIDE, Jr.,
F. H. HARVEY,
Executive Committee.

Sacramento, November 22, 1902.

Approved and adopted at meeting of Committee of Twenty-four, held at Sacramento City, December 7, 1902.

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